Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – SUMMER 2013

Subject Code: 160102 Date: 27-05-2013

Subject Name: Fundamentals of Jet Propulsion

Time: 10.30 am - 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive the Mach Area relation for nozzle and based on that discuss the shape of the duct required for different flow conditions. List the assumptions you considered. **07**

(b) A turbojet engine operates at a flight speed of 903.312 kmph at an altitude of 12km. The static properties at the 12kms are 216.65K, 0.193bar, 0.311Kg/m^3. The temperature at turbine inlet is 1500K, temperature drop (change) in turbine is 200°C, CV of fuel 43MJ/Kg, exhaust nozzle efficiency 94%, other components efficiency are 100%, velocity of gases at the exit of the jet pipe is sonic. Assume there is no pressure loss in diffuser. The pressure at the turbine entry is 98% of pressure at the compressor exit. Calculate flight Mach number, air fuel ratio, compressor pressure ratio, turbine pressure ratio, exhaust nozzle pressure ratio and the velocity of the exhaust jet. Neglect the mass of fuel while comparing works. **07**

Q.2 **(a)** In an open cycle gas turbine plant the air is compressed in a 2-stage compressor with complete intercooling and the gases are expanded in a 2-stage turbine with reheating in a second combustion chamber between the stages. Bothe the compressor stages are driven by high pressure turbine stage and the power output of the plant is taken form the low pressure turbine stage. The pressure ratio of each compressor is 2, the inlet static conditions are 1bar and 15°C, gas inlet temperature to both turbines is 700°C. isentropic efficiency of each compressor and turbine stage is 85%. Determine the output per kg of air per second and the thermal efficiency of the plant. Neglect pressure loss in intercooler and in combustion chamber. Variation in the mass flow of the working fluid due to addition of fuel is neglected. **07**

(b) A diverging sharp edged diffuse is employed on a ramjet engine which is designed for a flight Mach no. of 1.7. area at the entrance section 2.1 ft^2, total temperature of working fluid entering the nozzle 1945K, nozzle is choked neglect the mass of fuel and the diffuser operation is subcritical calculate Mach no. at exit to the diffuser, pressure ratio for the diffuser, and the Mach no at the entry to the Nozzle. The area ratio for the diffuser is 2.45. The static conditions at inlet are 248.3K, 0.465bar, 0.652kg/m^3. Use of gas table is permitted. **07**

OR

(b) Explain the ram jet diffuser operating conditions in brief. **07**

Q.3 **(a)** Draw the schematics of liquid propellant rocket engines and solid propellant rocket engines. List the comparative advantages and disadvantages for the both. **07**

(b) With a neat sketch explain the different zones of combustion chamber. **07**

OR

Q.3 **(a)** Explain in brief flame tune cooling and pressure losses in combustion chamber. **07**

(b) Write a short note on thrust reversals and thrust vectoring. **07**

Q.4	**(a)**	Describe the working of scramjet engine. What are its advantages over the ramjet?	**07**
	(b)	Define the term thrust produced by the jet engine. Derive the expressions for the propeller thrust and jet thrust.	**07**

OR

Q.4	**(a)**	Explain the need of propellant feed system and write a short note on gas pressure feed system of liquid propellant rocket engines.	**07**
	(b)	A supersonic diffuser has the following data at entry static pressure 1bar, static temperature 300K and Mach no. 2. The area ratio of diffuser A_1/A_2=1.6. Determine static properties, stagnation properties and the Mach no. at the exit to the diffuser.	**07**
Q.5	**(a)**	Derive the expression for the maximum mass flow rate through the convergent nozzle and explain the choking of nozzle.	**07**
	(b)	List the requirements of the combustion chamber.	**07**

OR

Q.5	**(a)**	Derive the expression for the thrust, specific impulse and specific propellant consumption for the rocket engine.	**07**
	(b)	Write a short note on effect of back pressure in convergent duct and the C-D nozzle.	**07**

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